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CHARACTERIZATION OF ORGANICS IN ATMOSPHERIC PARTICLES BY SINGLE PARTICLE MASS SPECTROMETRY

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Organics have been observed to be ubiquitous in atmospheric aerosols. They account to a significant fraction of the total aerosol mass (often between 20 and 50%) and play an important role in determining aerosol properties and on some occasion may dominate new particle formation. Current state-of-the-art techniques are capable of speciating only between 10 and 20% of the ambient aerosols. Understanding the fundamental processes, which constitute the "aerosol atmospheric life cycle", i.e., primary emission of aerosol or aerosol precursors, particle formation (gas to particle conversion), and growth is critical to be able to accurately portray the atmosphere in radiative or air quality models. These processes, which tend to be governed by complex gas - particle and particle - particle interactions, produce a rich spectrum of internally and externally mixed particles, with a wide distribution of sizes.

It is clear that a multitude of analytical methods will have to be deployed to address this complex problem. Single particle size and chemical composition analysis provides a unique approach that can distinguish between internally and externally mixed particles, as well as unambiguously identify the size of particles containing organics. This information can then be used to unravel the fundamental process behind the observations.

The BNL Single Particle Laser Ablation Time of Flight Mass Spectrometer (SPLAT-MS) was designed for in-situ characterization of the size and composition of individual aerosols between 80nm and 3micron in diameter. It uses an aerodynamic lens that acts to focus particles in the 20nm to 3 micrometer size range into a well-defined beam of ~1mm diameter with very low divergence and a throughput that nears 100%. Two stages of optical detection are used to indicate the presence of particles larger than 80nm and for velocity/size determination. Ablation laser synchronized with the particle's arrival at the inlet to the TOF-MS is used at present to evaporate and ionize the components for time of flight mass spectroscopic analysis. SPLAT-MS utilizes a reflectron time-of-flight mass spectrometer for single particle composition analysis. The resolving power of the instrument in mass-to-charge units is 1000. The TOF-MS spectra are digitized at a rate of 500 MHz, and data is transferred to the computer. The overall system is capable of analysis of 30 particles per second. Development of methods to characterize the organic fraction of the aerosol mass is one of the more important challenges facing atmospheric aerosol research. The large number of possible compounds and their tendency to fragment during the ablation process produce very rich and difficult to interpret spectra.

The instrument was recently deployed during the TX 2000 field study. Preliminary analysis of the data indicates a rich spectrum of particle composition, many of which contain a large organic fraction. Some of the findings from this study will be presented and compared with laboratory generated aerosols.

New approaches that use thermal desorption/evaporation, followed by a gentle 2-photon ionization and high-resolution mass spectroscopy, promise to provide significantly improved spectra.

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